Imaging Dissociation Processes in Neutral Molecules and Ions

Fernando Aguirre and Stephen T. Pratt

Researchers in the Chemistry Division at Argonne National Laboratory have recently studied the photodissociation of CF_3I and CF_3I^+ by using resonantly enhanced multiphoton ionization and velocity-map imaging techniques. This approach provides a two-dimensional picture of the three-dimensional velocity distribution of the dissociation products. As an example, Figure 1 shows the image obtained by selectively detecting excited $I(^2P_{1/2})$ atoms produced by the photodissociation of CF_3I. The diameter of the rings is related to the translational energy of the I atoms. Rings of different diameter are observed because the CF_3 fragment can be produced with different amounts of internal vibrational energy, which results in different amounts of energy available for the translational energy of the I atom. The integrated intensity of each ring allows a determination of the vibrational state distribution of the CF_3 fragment. In addition, the intensity variation around a given ring provides information on the angular distribution of the fragments. The image shown here allows the first determination of the photofragment angular distributions as a function of the vibrational level of the CF_3. These distributions provide new information on the photodissociation mechanism and the potential energy surfaces of excited states of CF_3I. Analogous measurements have also been performed on the photodissociation of CF_3I^+, which will help to resolve some outstanding questions about the photoionization dynamics of this molecule. Future velocity-map imaging studies of photodissociation processes will be coupled with parallel studies of the photoionization dynamics, allowing a complete picture of the decay mechanisms of highly excited molecules. Such studies will provide fundamental insight into the flow of energy among the internal degrees of freedom of these molecules and ultimately lead to a better understanding of elementary chemical processes.

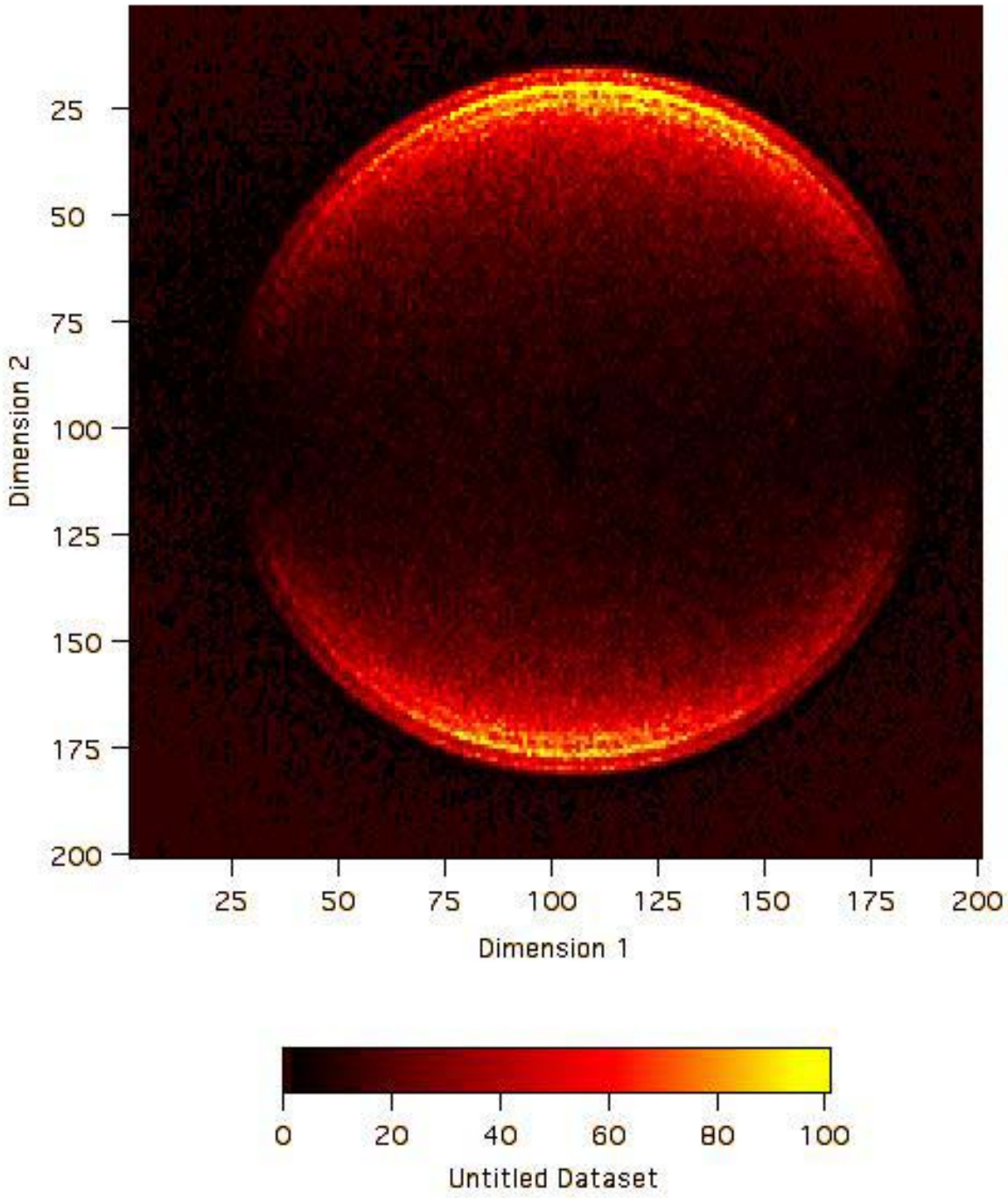
25
50
75
100
125
150
175
200
Dimension 2
25
50
75
100
125
150
175
200
Dimension 1
0
20
40
60
80
100
Untitled Dataset

Figure 1